

## Appendix H

# Comparisons With Other Forecasts, and Performance of Past *IEO* Forecasts for 1990, 1995, and 2000

## Forecast Comparisons

### Energy Consumption by Region

Three organizations provide forecasts comparable with the projections in *IEO2006*, which extend to 2030 for the first time. The International Energy Agency (IEA) provides “business as usual” projections to 2030 in its *World Energy Outlook 2004*; Petroleum Economics, Ltd. (PEL) publishes world energy projections to 2025; and Petroleum Industry Research Associates (PIRA) provides projections to 2020. For comparison, 2002 is used as the base year for all the projections. Comparisons between *IEO2006* and *IEO2005* extend only to 2025, the last year of the *IEO2005* projections.

Regional breakouts vary among the different projections, complicating the comparisons. For example, *IEO2006*, PIRA, and IEA include Mexico in OECD North America, but PEL includes Mexico in Latin America. Because PEL does not provide separate projections for Mexico, its numbers for North America are somewhat

inconsistent with the other projections. PIRA includes only Japan in OECD Asia, whereas OECD Asia in the *IEO2006* and IEA projections comprises Japan, South Korea, Australia, and New Zealand. *IEO2006* and IEA provide forecasts for OECD Europe, which includes Turkey, the Czech Republic, Hungary, Poland, and Slovakia. PEL places Turkey in Western Europe but includes all Eastern and Western European countries in “Europe,” including those that are not OECD members. *IEO2005* reported Eastern Europe and Western Europe separately and, in addition, placed Turkey in the Middle East. PIRA reports the Eastern European countries in its former Soviet Union region. The differences in the regional aggregations contribute to the variations among the forecasts.

All the forecasts provide projections out to 2010 (Table H1). The 2002-2010 projections vary widely, reflecting in part the volatility of world energy markets over the past several years. Growth rates for energy consumption among the reference case forecasts range from 2.2

**Table H1. Comparison of Energy Consumption Growth Rates by Region, 2002-2010**  
(Average Annual Percent Growth)

Region	<i>IEO2006</i>			<i>IEO2005</i>	IEA	PIRA	PEL
	Low Growth	Reference	High Growth				
<b>OECD</b> .....	<b>1.0</b>	<b>1.2</b>	<b>1.5</b>	<b>1.3</b>	<b>1.4</b>	<b>1.2</b>	<b>1.2</b>
North America .....	1.1	1.4	1.7	1.7	1.5	1.3	1.4
Europe .....	0.8	1.0	1.2	0.5	1.1	1.3	1.3
Asia .....	1.0	1.2	1.4	1.3	1.6	0.4	0.5
<b>Non-OECD</b> .....	<b>4.0</b>	<b>4.5</b>	<b>5.0</b>	<b>3.9</b>	<b>2.8</b>	<b>3.9</b>	<b>3.8</b>
Europe and Eurasia .....	1.9	2.4	2.8	2.0	1.8	2.5	1.6
China .....	7.3	7.8	8.4	6.8	3.4	7.0	6.2
Other Non-OECD Asia .....	3.5	3.9	4.5	3.9	3.2	3.0	3.7
Middle East .....	3.0	3.4	3.9	3.4	3.2	4.8	4.5
Africa .....	3.7	4.2	4.6	3.4	2.7	3.3	3.0
Central and South America . . .	3.0	3.6	4.0	3.0	2.7	2.5	2.4
<b>Total World</b> .....	<b>2.4</b>	<b>2.7</b>	<b>3.1</b>	<b>2.6</b>	<b>2.2</b>	<b>2.7</b>	<b>2.4</b>

Notes: For *IEO2005*, the Czech Republic, Hungary, Poland, and Slovakia are included in non-OECD Europe and Eurasia; for *IEO2006* they are included in OECD Europe. For PIRA, all Eastern European and former Soviet Union countries are included in non-OECD Europe and Eurasia, OECD Asia includes only Japan, and Australia/New Zealand and South Korea are included in other non-OECD Asia. For PEL, OECD Europe includes both Western Europe and Eastern Europe, and non-OECD Europe and Eurasia includes only the former Soviet Union.

Sources: **IEO2006**: Energy Information Administration (EIA), System for the Analysis of Global Energy Markets (2006). **IEO2005**: EIA, *International Energy Outlook 2005*, DOE/EIA-0484(2005) (Washington, DC, July 2005), Table A1, p. 89. **IEA**: International Energy Agency, *World Energy Outlook 2004* (Paris, France, October 2004), pp. 430-517. **PIRA**: PIRA Energy Group, *Retainer Client Seminar* (New York, NY, October 2005), Table II-4. **PEL**: Petroleum Economics, Ltd., *World Long Term Oil and Energy Outlook* (London, United Kingdom, May 2005), Tables 3i and 3ii.

percent per year (IEA) to 2.7 percent per year (*IEO2006* and *PIRA*). All agree that OECD energy demand will expand more slowly than non-OECD demand, and that the fastest growth in world energy use will occur in non-OECD Asia; however, within the OECD, the *IEO2006* reference case, as well as the IEA business as usual case, show slower energy demand growth for Europe than do PEL and *PIRA*. Both PEL and *PIRA* show growth in the region that exceeds the *IEO2006* high economic growth case projection for the 2002-2010 period.

IEA anticipates much higher growth for OECD Asia than do any of the other forecasts, and the IEA growth rate exceeds that in the *IEO2006* high economic growth case. It should be noted that the IEA forecast is the oldest of the five being compared, which could explain its deviation from the other forecasts in the short term. A 2005 edition of the IEA's *World Energy Outlook* has been released, but it does not contain a complete worldwide forecast of energy demand by region and, as a result, could not be used for this comparison.

*PIRA* and PEL report much lower growth rates for OECD Asia than does *IEO2006*. Their growth rates fall below those in the *IEO2006* low economic growth case. For *PIRA*, this may be because the figures do not include projections for South Korea (in addition to Japan, Australia, and New Zealand). For PEL, expectations that Japan's energy use will decline over the 2002-2010

period counter fairly strong growth projected for South Korea and Australia/New Zealand.

*IEO2006* anticipates overall growth among the non-OECD nations that is somewhat higher than other forecasts over the 2002-2010 period. Non-OECD growth rates range from 2.8 percent per year (IEA) to 4.5 percent per year (*IEO2006*). The growth rates for total non-OECD energy demand in the other forecasts fall below the *IEO2006* low economic growth case. For China, Africa, and Central and South America, all the other forecasts fall below the *IEO2006* low economic growth case. The only region in which *IEO2006* shows slower growth than the other projections is the Middle East, where the PEL and *PIRA* growth rates for 2002-2010 exceed those in the *IEO2006* high economic growth case.

The *IEO2006* and *IEO2005* reference case projections for the OECD in the 2002-2010 period are similar. An exception is OECD Europe, for which *IEO2005* did not include the Czech Republic, Hungary, Poland, Slovakia, or Turkey—all economies with potentially more rapid growth than the more mature economies of Western Europe, including Germany, France, Italy, and the United Kingdom. Among the non-OECD regions, the *IEO2005* growth rates for China and Africa are much lower than this year's projections, falling below the *IEO2006* low economic growth case.

*IEO2006*, *PIRA*, and PEL provide forecasts for energy use in 2015 (Table H2). Their reference case projections

**Table H2. Comparison of Energy Consumption Growth Rates by Region, 2002-2015**  
(Average Annual Percent Growth)

Region	<i>IEO2006</i>			<i>IEO2005</i>	<i>PIRA</i>	PEL
	Low Growth	Reference	High Growth			
<b>OECD</b> .....	<b>0.9</b>	<b>1.2</b>	<b>1.4</b>	<b>1.2</b>	<b>1.1</b>	<b>1.1</b>
North America .....	1.1	1.4	1.6	1.5	1.2	1.3
Europe .....	0.7	0.9	1.1	0.5	1.1	1.1
Asia .....	1.0	1.2	1.5	1.3	0.4	0.6
<b>Non-OECD</b> .....	<b>3.3</b>	<b>3.9</b>	<b>4.5</b>	<b>3.4</b>	<b>3.6</b>	<b>3.5</b>
Europe and Eurasia .....	1.8	2.3	2.8	1.9	2.3	1.4
China .....	5.6	6.2	6.8	5.4	6.1	5.2
Other Non-OECD Asia .....	3.0	3.6	4.2	3.5	2.8	3.6
Middle East .....	2.5	3.1	3.6	3.0	4.7	4.3
Africa .....	3.2	3.7	4.3	3.2	2.9	2.9
Central and South America ....	2.6	3.3	3.8	2.8	2.3	2.4
<b>Total World</b> .....	<b>2.0</b>	<b>2.5</b>	<b>2.9</b>	<b>2.3</b>	<b>2.5</b>	<b>2.2</b>

Notes: For *IEO2005*, the Czech Republic, Hungary, Poland, and Slovakia are included in non-OECD Europe and Eurasia; for *IEO2006* they are included in OECD Europe. For *PIRA*, all Eastern European and former Soviet Union countries are included in non-OECD Europe and Eurasia, OECD Asia includes only Japan, and Australia/New Zealand and South Korea are included in other non-OECD Asia. For PEL, OECD Europe includes both Western Europe and Eastern Europe, and non-OECD Europe and Eurasia includes only the former Soviet Union.

Sources: **IEO2006**: Energy Information Administration (EIA), System for the Analysis of Global Energy Markets (2006). **IEO2005**: EIA, *International Energy Outlook 2005*, DOE/EIA-0484(2005) (Washington, DC, July 2005), Table A1, p. 89. **PIRA**: PIRA Energy Group, *Retainer Client Seminar* (New York, NY, October 2005), Table II-4. **PEL**: Petroleum Economics, Ltd., *World Long Term Oil and Energy Outlook* (London, United Kingdom, May 2005), Tables 3i and 3ii.

for worldwide growth in energy consumption from 2002 to 2015 vary from 2.2 percent per year (PEL) to 2.5 percent per year (*IEO2006* and PIRA). As was true for the 2002-2010 period, PEL and PIRA show much faster growth in energy use for the Middle East from 2002 to 2015 than does *IEO2006*, exceeding the *IEO2006* high economic growth case. Moreover, both the PEL and PIRA forecasts for demand growth in Africa and in Central and South America fall well below those in the *IEO2006* reference case. PEL also projects much slower growth than does *IEO2006* for China and for non-OECD Europe and Eurasia in the 2002-2015 period, below the *IEO2006* low economic growth case projections. PIRA's projections for the two regions closely resemble those in the *IEO2006* reference case. All the forecasts have similar expectations for overall growth among the OECD nations, but as was true for the 2002-2010 comparisons, the PEL and PIRA growth rates for OECD Asia are much lower than in the *IEO2006* reference case.

The *IEO2006* reference case projection for worldwide growth in energy use from 2002 to 2015, at 2.5 percent per year, is higher than projected in *IEO2005*. By region, the largest differences between the two forecasts are for OECD Europe and for China, both of which are below those in the *IEO2006* low economic growth case. In the case of China, the unanticipated strong expansion in income and resulting energy demand in 2003 and 2004—

especially for oil but also for other fuels—was not fully anticipated in last year's forecast. For both OECD Europe and non-OECD Europe and Eurasia, economic growth is slightly higher in *IEO2006*.

All the forecasts provide energy consumption projections for 2020 (Table H3), PIRA's final forecast year. The four forecasts have similar projections for energy demand growth from 2002 to 2020, with average annual increases in the world's total energy consumption that range from 1.9 percent (IEA) to 2.3 percent (*IEO2006*) and with non-OECD growth higher than the OECD growth rate. The largest variation among the regional projections is for China, ranging from 2.9 percent per year (IEA) to 4.6 percent per year (*IEO2006*). For 2002-2020, as for 2002-2015, the PEL and PIRA projections for OECD Asia falling below the *IEO2006* low economic growth case.

The largest differences between the *IEO2006* and *IEO2005* reference case growth rates for energy demand from 2002 to 2020 are for China and OECD Europe. *IEO2005* projected annual energy demand growth for China that is 0.7 percentage points lower than in *IEO2006*; and the *IEO2005* reference case projection for OECD Europe is lower than in the *IEO2006* low economic growth case, largely due to lower expectations for economic growth and differences in regional definitions.

**Table H3. Comparison of Energy Consumption Growth Rates by Region, 2002-2020**  
(Average Annual Percent Growth)

Region	<i>IEO2006</i>			<i>IEO2005</i>	IEA	PIRA	PEL
	Low Growth	Reference	High Growth				
<b>OECD</b> .....	<b>0.8</b>	<b>1.1</b>	<b>1.4</b>	<b>1.1</b>	<b>1.1</b>	<b>1.1</b>	<b>1.0</b>
North America .....	1.0	1.3	1.6	1.5	1.2	1.2	1.2
Europe .....	0.6	0.7	0.9	0.5	0.9	1.2	0.9
Asia .....	0.8	1.1	1.4	1.1	1.3	0.4	0.6
<b>Non-OECD</b> .....	<b>2.9</b>	<b>3.5</b>	<b>4.1</b>	<b>3.1</b>	<b>2.6</b>	<b>3.3</b>	<b>3.3</b>
Europe and Eurasia .....	1.6	2.1	2.8	1.7	1.5	2.1	1.3
China .....	4.6	5.3	6.0	4.6	2.9	5.5	4.6
Other Non-OECD Asia .....	2.7	3.4	4.0	3.3	2.9	2.6	3.5
Middle East .....	2.2	2.8	3.4	2.7	3.0	4.4	4.1
Africa .....	2.6	3.2	3.8	2.9	2.6	2.6	2.8
Central and South America . . .	2.3	3.0	3.7	2.5	2.7	2.1	2.4
<b>Total World</b> .....	<b>1.8</b>	<b>2.3</b>	<b>2.7</b>	<b>2.1</b>	<b>1.9</b>	<b>2.4</b>	<b>2.1</b>

Notes: For *IEO2005*, the Czech Republic, Hungary, Poland, and Slovakia are included in non-OECD Europe and Eurasia; for *IEO2006* they are included in OECD Europe. For PIRA, all Eastern European and former Soviet Union countries are included in non-OECD Europe and Eurasia, OECD Asia includes only Japan, and Australia/New Zealand and South Korea are included in other non-OECD Asia. For PEL, OECD Europe includes both Western Europe and Eastern Europe, and non-OECD Europe and Eurasia includes only the former Soviet Union.

Sources: **IEO2006**: Energy Information Administration (EIA), System for the Analysis of Global Energy Markets (2006). **IEO2005**: EIA, *International Energy Outlook 2005*, DOE/EIA-0484(2005) (Washington, DC, July 2005), Table A1, p. 89. **IEA**: International Energy Agency, *World Energy Outlook 2004* (Paris, France, October 2004), pp. 430-517. **PIRA**: PIRA Energy Group, *Retainer Client Seminar* (New York, NY, October 2005), Table II-4. **PEL**: Petroleum Economics, Ltd., *World Long Term Oil and Energy Outlook* (London, United Kingdom, May 2005), Tables 3i and 3ii.

Only the *IEO2006* and PEL projections cover 2025 (IEA extends to 2030 but does not include projections for 2025). The two forecasts are largely in agreement on a worldwide basis (Table H4), with PEL projecting 2.0-percent average annual growth in world energy demand and *IEO2006* 2.1 percent. There are some regional differences between the two, particularly for OECD Asia, non-OECD Europe and Eurasia, and the Middle East. For the Middle East, the PEL projections exceed the *IEO2006* high economic growth case, as they

do for the other time periods compared here. Although the *IEO2006* and PEL projections for economic growth in the Middle East region are similar (4.3 percent and 4.0 percent per year, respectively), *IEO2006* projects stronger gains in energy intensity over the 2002-2025 period, whereas PEL expects GDP and energy demand to continue increasing at about the same pace.

*IEO2006* and IEA are the only projections that run through 2030 (Table H5). Generally they agree, with

**Table H4. Comparison of Energy Consumption Growth Rates by Region, 2002-2025**  
(Average Annual Percent Growth)

Region	<i>IEO2006</i>			<i>IEO2005</i>	PEL
	Low Growth	Reference	High Growth		
<b>OECD</b> .....	<b>0.8</b>	<b>1.0</b>	<b>1.3</b>	<b>1.1</b>	<b>0.9</b>
North America .....	0.9	1.3	1.6	1.4	1.1
Europe .....	0.5	0.7	0.9	0.5	0.8
Asia .....	0.7	1.0	1.3	1.1	0.6
<b>Non-OECD</b> .....	<b>2.6</b>	<b>3.2</b>	<b>3.9</b>	<b>2.8</b>	<b>3.1</b>
Europe and Eurasia .....	1.4	2.0	2.6	1.6	1.2
China .....	4.0	4.7	5.4	4.1	4.1
Other Non-OECD Asia .....	2.6	3.2	4.0	3.1	3.4
Middle East .....	2.0	2.6	3.2	2.5	4.0
Africa .....	2.3	2.8	3.5	2.7	2.8
Central and South America ....	2.2	2.9	3.5	2.3	2.4
<b>Total World</b> .....	<b>1.6</b>	<b>2.1</b>	<b>2.6</b>	<b>2.0</b>	<b>2.0</b>

Notes: For *IEO2005*, the Czech Republic, Hungary, Poland, and Slovakia are included in non-OECD Europe and Eurasia; for *IEO2006* they are included in OECD Europe. For PEL, OECD Europe includes both Western Europe and Eastern Europe, and non-OECD Europe and Eurasia includes only the former Soviet Union.

Sources: **IEO2006**: Energy Information Administration (EIA), System for the Analysis of Global Energy Markets (2006). **IEO2005**: EIA, *International Energy Outlook 2005*, DOE/EIA-0484(2005) (Washington, DC, July 2005), Table A1, p. 89. **PEL**: Petroleum Economics, Ltd., *World Long Term Oil and Energy Outlook* (London, United Kingdom, May 2005), Tables 3i and 3ii.

**Table H5. Comparison of Energy Consumption Growth Rates by Region, 2002-2030**  
(Average Annual Percent Growth)

Region	<i>IEO2006</i>			IEA
	Low Growth	Reference	High Growth	
<b>OECD</b> .....	<b>0.7</b>	<b>1.0</b>	<b>1.3</b>	<b>0.9</b>
North America .....	0.9	1.2	1.6	1.1
Europe .....	0.5	0.7	0.9	0.7
Asia .....	0.7	1.0	1.3	1.0
<b>Non-OECD</b> .....	<b>2.4</b>	<b>3.0</b>	<b>3.8</b>	<b>2.4</b>
Europe and Eurasia .....	1.3	1.9	2.5	1.3
China .....	3.6	4.4	5.1	2.6
Other Non-OECD Asia .....	2.4	3.1	3.9	2.7
Middle East .....	1.9	2.5	3.1	2.5
Africa .....	2.1	2.7	3.4	2.6
Central and South America ....	2.0	2.8	3.4	2.6
<b>Total World</b> .....	<b>1.5</b>	<b>2.0</b>	<b>2.6</b>	<b>1.8</b>

Sources: **IEO2006**: Energy Information Administration (EIA), System for the Analysis of Global Energy Markets (2006). **IEO2005**: EIA, *International Energy Outlook 2005*, DOE/EIA-0484(2005) (Washington, DC, July 2005), Table A1, p. 89. **IEA**: International Energy Agency, *World Energy Outlook 2004* (Paris, France, October 2004), pp. 430-517.

worldwide energy demand growing by 2.0 percent per year from 2002 to 2030 in the *IEO2006* reference case and by 1.8 percent per year in the IEA business as usual case. The largest difference between the two is for China: the IEA projection for China is nearly 2 percentage points lower than the *IEO2006* reference case and is a full percentage point lower than the *IEO2006* low economic growth case.

### Energy Consumption by Fuel

The forecasts vary not only with respect to levels of total energy demand but also with respect to the mix of primary energy inputs. All the forecasts provide energy consumption projections by fuel in 2010 (Table H6), with a wide range of views regarding the mix of fuels that will be used to meet projected demand. Whereas *IEO2006* and PIRA expect coal to be the fastest growing fuel source in the 2002-2010 period—at 3.6 percent per year and 3.4 percent per year, respectively—IEA and PEL expect much lower growth for coal.

IEA and PEL project relatively strong growth in nuclear power demand over the time period, whereas the

*IEO2006* and PIRA projections are relatively modest. *IEO2006*, IEA, and PIRA project average growth in worldwide renewable energy use at more than 3.0 percent per year from 2002 to 2010; in contrast, PEL projects an average of 1.9 percent per year. All the projections for growth in world oil demand are between 2.0 percent per year (*IEO2006* and IEA) and 2.2 percent per year (PEL), and all expect relatively strong growth in natural gas use.

In comparison with *IEO2005*, the *IEO2006* projections are lower for oil and nuclear power and higher for every other energy source. The *IEO2006* projection for world oil prices in the 2002-2010 period are higher, leading to slower growth in oil demand and fuel substitution where possible. For nuclear power, *IEO2006* projects slightly slower growth in generating capacity through 2010 and lower capacity utilization rates for some than were projected in *IEO2005*.

PEL, PIRA, and *IEO2006* provide world energy consumption projections by fuel for 2015 (Table H7). Again, the forecasts agree on the outlook for oil demand, with

**Table H6. Comparison of World Energy Consumption Growth Rates by Fuel, 2002-2010**  
(Average Annual Percent Growth)

Fuel	<i>IEO2006</i>			<i>IEO2005</i>	IEA	PIRA	PEL
	Low Growth	Reference	High Growth				
Oil .....	1.6	2.0	2.3	2.4	2.0	2.1	2.2
Natural Gas .....	2.6	3.0	3.5	2.4	2.7	2.9	3.1
Coal .....	3.3	3.6	4.0	3.1	1.8	3.4	1.9
Nuclear .....	1.0	1.0	1.0	1.5	1.5	0.7	2.6
Renewable/Other .....	4.1	4.3	4.4	2.7	3.2	3.6	1.9
<b>Total .....</b>	<b>2.4</b>	<b>2.7</b>	<b>3.1</b>	<b>2.6</b>	<b>2.2</b>	<b>2.7</b>	<b>2.4</b>

Note: For IEA, Renewable/Other excludes traditional biomass.

Sources: *IEO2006*: Energy Information Administration (EIA), System for the Analysis of Global Energy Markets (2006). *IEO2005*: EIA, *International Energy Outlook 2005*, DOE/EIA-0484(2005) (Washington, DC, July 2005), Table A2, p. 91. *IEA*: International Energy Agency, *World Energy Outlook 2004* (Paris, France, October 2004), pp. 430-517. *PIRA*: PIRA Energy Group, *Retainer Client Seminar* (New York, NY, October 2005). *PEL*: Petroleum Economics, Ltd., *World Long Term Oil and Energy Outlook* (London, United Kingdom, May 2005).

**Table H7. Comparison of World Energy Consumption Growth Rates by Fuel, 2002-2015**  
(Average Annual Percent Growth)

Fuel	<i>IEO2006</i>			<i>IEO2005</i>	PIRA	PEL
	Low Growth	Reference	High Growth			
Oil .....	1.3	1.8	2.2	2.2	1.9	1.9
Natural Gas .....	2.4	2.9	3.5	2.6	2.8	3.2
Coal .....	2.7	3.1	3.6	2.6	3.1	1.7
Nuclear .....	1.1	1.2	1.2	1.3	0.7	2.3
Renewable/Other .....	2.9	3.3	3.5	2.2	3.3	2.1
<b>Total .....</b>	<b>2.0</b>	<b>2.5</b>	<b>2.9</b>	<b>2.3</b>	<b>2.5</b>	<b>2.2</b>

Sources: *IEO2006*: Energy Information Administration (EIA), System for the Analysis of Global Energy Markets (2006). *IEO2005*: EIA, *International Energy Outlook 2005*, DOE/EIA-0484(2005) (Washington, DC, July 2005), Table A2, p. 91. *PIRA*: PIRA Energy Group, *Retainer Client Seminar* (New York, NY, October 2005). *PEL*: Petroleum Economics, Ltd., *World Long Term Oil and Energy Outlook* (London, United Kingdom, May 2005).

growth rates ranging from 1.8 percent per year (*IEO2006*) to 1.9 percent per year (PEL and PIRA) from 2002 to 2015. There is a wider range of expectations for the other energy sources. The largest variation is for nuclear power generation, ranging from 0.7 percent per year (PIRA) to 2.3 percent per year (PEL), with *IEO2006* at 1.2 percent per year. PEL's bullish forecast for nuclear power offsets its fairly pessimistic forecasts for coal (1.7 percent per year) and renewables (2.1 percent per year). Both *IEO2006* and PIRA project average demand growth of 3.1 percent per year for coal and 3.3 percent per year for renewables.

All the forecasts provide energy consumption projections for 2020 (Table H8). They are largely in agreement on the growth rate for world oil use, at 1.6 percent (*IEO2006*), 1.7 percent (PEL), and 1.8 percent per year (IEA and PIRA) from 2002 to 2020. Expectations for the other energy sources differ. Again, the largest differences are in the projections for nuclear power. The projections for growth in nuclear power generation vary from 0.6 percent per year (IEA) to 2.2 percent per year (PEL), with *IEO2006* projecting 1.2 percent per year. Among the growth projections for total world energy

consumption from 2002 to 2020, IEA and PEL are lower than *IEO2006* and PIRA, and IEA is the lowest.

The *IEO2006* reference case projections for growth in oil consumption from 2002 to 2020 are lower than those in *IEO2005* as a result of the higher oil prices in *IEO2006*. For all other energy sources, the *IEO2006* projections are higher, with other fuels replacing oil where possible. In particular, coal demand is expected to grow by 2.8 percent per year from 2002 to 2020 in *IEO2006*, compared with 2.3 percent per year in *IEO2005*. Growth in renewable energy use is also significantly higher in *IEO2006*, at 2.8 percent per year, as compared with 1.9 percent per year in *IEO2005*. For natural gas, higher prices that result from increased demand as natural gas replaces oil use, mostly for industrial purposes, make renewable energy sources more competitive, especially for electric power generation.

As noted above, the only two forecasts for the 2002-2025 period, *IEO2006* and PEL, are largely in agreement with respect to the increase in total energy demand (Table H9). PEL projects average annual growth of 2.0 percent for total world demand and *IEO2006* 2.1 percent per

**Table H8. Comparison of World Energy Consumption Growth Rates by Fuel, 2002-2020**  
(Average Annual Percent Growth)

Fuel	<i>IEO2006</i>			<i>IEO2005</i>	IEA	PIRA	PEL
	Low Growth	Reference	High Growth				
Oil .....	1.1	1.6	2.1	2.0	1.8	1.8	1.7
Natural Gas .....	2.3	2.7	3.2	2.4	2.6	2.7	3.1
Coal .....	2.3	2.8	3.4	2.3	1.6	2.7	1.5
Nuclear .....	1.1	1.2	1.2	1.1	0.6	1.6	2.2
Renewable/Other .....	2.3	2.8	3.2	1.9	2.7	3.2	2.1
<b>Total .....</b>	<b>1.8</b>	<b>2.3</b>	<b>2.7</b>	<b>2.1</b>	<b>1.9</b>	<b>2.4</b>	<b>2.1</b>

Note: For IEA, Renewable/Other excludes traditional biomass.

Sources: ***IEO2006***: Energy Information Administration (EIA), System for the Analysis of Global Energy Markets (2006). ***IEO2005***: EIA, *International Energy Outlook 2005*, DOE/EIA-0484(2005) (Washington, DC, July 2005), Table A2, p. 91. **IEA**: International Energy Agency, *World Energy Outlook 2004* (Paris, France, October 2004), pp. 430-517. **PIRA**: PIRA Energy Group, *Retainer Client Seminar* (New York, NY, October 2005). **PEL**: Petroleum Economics, Ltd., *World Long Term Oil and Energy Outlook* (London, United Kingdom, May 2005).

**Table H9. Comparison of World Energy Consumption Growth Rates by Fuel, 2002-2025**  
(Average Annual Percent Growth)

Fuel	<i>IEO2006</i>			<i>IEO2005</i>	PEL
	Low Growth	Reference	High Growth		
Oil .....	1.0	1.5	2.1	1.9	1.4
Natural Gas .....	2.1	2.6	3.0	2.3	3.1
Coal .....	2.1	2.7	3.3	2.0	1.4
Nuclear .....	1.0	1.1	1.1	1.0	2.1
Renewable/Other .....	2.1	2.6	3.0	1.9	2.1
<b>Total .....</b>	<b>1.6</b>	<b>2.1</b>	<b>2.6</b>	<b>2.0</b>	<b>2.0</b>

Sources: ***IEO2006***: Energy Information Administration (EIA), System for the Analysis of Global Energy Markets (2006). ***IEO2005***: EIA, *International Energy Outlook 2005*, DOE/EIA-0484(2005) (Washington, DC, July 2005), Table A2, p. 91. **PEL**: Petroleum Economics, Ltd., *World Long Term Oil and Energy Outlook* (London, United Kingdom, May 2005).

year. The fuel mix does vary between the two forecasts, however, with PEL projecting stronger growth in natural gas use and nuclear power generation than *IEO2006*. PEL's growth rate for natural gas demand exceeds the projection in the *IEO2006* high economic growth case and is a full percentage point higher than the *IEO2006* projection for nuclear power. In contrast, *IEO2006* expects stronger growth in coal and renewable energy use. The *IEO2006* reference case shows generally higher consumption growth rates for all fuels from 2002 to 2025, except for oil.

*IEO2006* and IEA are the only forecasts that extend to 2030 (Table H10). In the IEA projections, worldwide energy use grows at a slower pace than in the *IEO2006* reference case (1.7 percent and 2.0 percent per year, respectively). IEA projects somewhat higher growth for oil and renewable energy demand than does *IEO2006*, but much lower growth for coal and nuclear power consumption. The IEA growth forecast for coal use is a full percentage point lower than the *IEO2006* reference case and falls below the *IEO2006* low economic growth case. Similarly, the IEA projection for growth in nuclear power generation (0.4 percent per year) is less than one-half the *IEO2006* projection (0.9 percent per year).

## Performance of Past *IEO* Forecasts for 1990, 1995, and 2000

In an effort to measure how well the *IEO* projections have estimated future energy consumption trends over the 20-year history of the series, a comparison of *IEO* forecasts produced for the years 1990, 1995, and 2000 is presented here. The forecasts are compared with actual data published in EIA's *International Energy Annual 2002*, as part of EIA's commitment to provide users of the *IEO* with a set of performance measures to assess the forecasts produced by this agency.

The *IEO* has been published since 1985. In *IEO85*, mid-term projections were derived only for the world's market economies. That is, no projections were prepared

for the centrally planned economies (CPE) of the Soviet Union, Eastern Europe, Cambodia, China, Cuba, Laos, Mongolia, North Korea, and Vietnam. The *IEO85* projections extended to 1995 and included forecasts of energy consumption for 1990 and 1995 and primary consumption of oil, natural gas, coal, and "other fuels." *IEO85* projections were also presented for several individual countries and subregions: the United States, Canada, Japan, the United Kingdom, France, West Germany, Italy, the Netherlands, other OECD Europe, other OECD (Australia, New Zealand, and the U.S. Territories), OPEC, and other developing countries. Beginning with *IEO86*, nuclear power projections were published separately from the "other fuel" category.

Regional aggregations have changed from report to report. In 1990, the report coverage was expanded for the first time from only the market economies to the entire world. Projections for China, the FSU, and other CPE countries were provided separately. Starting with *IEO94*, the regional presentation was changed from market economies and CPE countries to OECD, Eurasia (China, FSU, and Eastern Europe), and "Rest of World." Beginning in 1995 and essentially continuing until the current issue, the regional presentation changed to further group the nations of the world according to economic development: industrialized nations (essentially the OECD before the entry of South Korea and the Eastern European nations, the Czech Republic, Hungary, Poland, and Slovakia), the transitional economies of the EE/FSU, and the developing world (including China and India).

The forecast time horizon has also changed over the years (Table H11). In the first edition of the report, *IEO85*, projections were made for 1990 and 1995. *IEO86* saw the addition of projection year 2000. In *IEO91*, forecasts were no longer published for 1990, but forecasts for 2010 were added. The projection horizon remained the same until *IEO96*, when projection year 2015 was added. In 1998, the forecast was extended again, out to 2020. With *IEO2003*, the forecast period was extended to 2025;

**Table H10. Comparison of World Energy Consumption Growth Rates by Fuel, 2002-2030**  
(Average Annual Percent Growth)

Fuel	<i>IEO2006</i>			IEA
	Low Growth	Reference	High Growth	
Oil . . . . .	1.0	1.5	2.0	1.6
Natural Gas . . . . .	2.0	2.5	3.0	2.3
Coal . . . . .	2.0	2.5	3.2	1.5
Nuclear . . . . .	0.9	0.9	0.9	0.4
Renewable/Other . . . . .	1.9	2.4	3.0	2.7
<b>Total . . . . .</b>	<b>1.5</b>	<b>2.0</b>	<b>2.6</b>	<b>1.7</b>

Note: For IEA, Renewable/Other excludes traditional biomass.

Sources: *IEO2006*: Energy Information Administration (EIA), System for the Analysis of Global Energy Markets (2006). IEA: International Energy Agency, *World Energy Outlook 2004* (Paris, France, October 2004), pp. 430-517.

and for the first time, the forecast period extends to 2030 in *IEO2006*.

### Comparisons of Forecasts for Market Economies

Projections for market economies were made in the eight issues of the *IEO* that were published between 1985 and 1993 (no *IEO* was published in 1988). Historical data for total regional energy consumption in 1990 show that the *IEO* projections from those early years were consistently lower than the actual data for the market economies. For the four editions of the *IEO* printed between 1985 and 1989 in which 1990 projections were presented, total projected energy consumption in the market economies ran between 4 and 7 percent below the actual amounts published in the *International Energy Annual 2001* (Figure H1).

In addition, market economy projections for 1995 in the 1985 through 1993 *IEO* reports (EIA did not release forecasts for 1995 after the 1993 report) were consistently lower than the actual, historical 1995 data (Figure H2). Most of the difference is attributed to those market economy countries outside the OECD. Through the years, EIA's economic growth assumptions for OPEC and other market economy countries outside the OECD have been low. The 1993 forecast was, as one might expect, the most accurate of the forecasts for 1995, and its projection for OPEC and the other market economy countries was about 2 percent below the actual number.

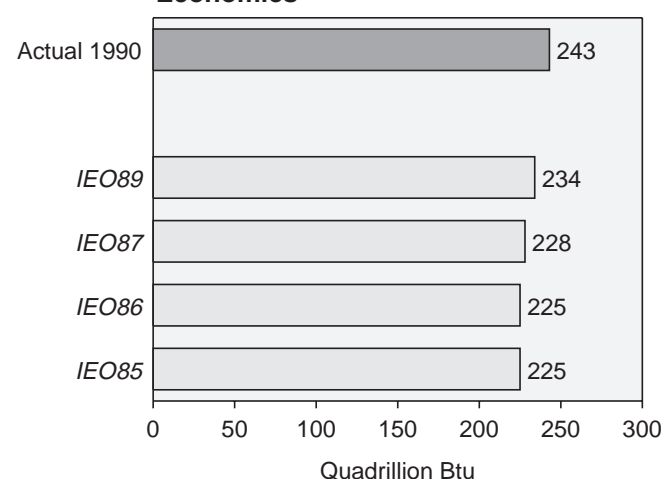
**Table H11. Years Included in *IEO* Projections by Edition, 1985-2006**

Edition	1990	1995	2000	2005	2010	2015	2020	2025	2030
<i>IEO85</i> . . . .	x	x							
<i>IEO86</i> . . . .	x	x	x						
<i>IEO87</i> . . . .	x	x	x						
<i>IEO89</i> . . . .	x	x	x						
<i>IEO90</i> . . . .		x	x		x				
<i>IEO91</i> . . . .		x	x		x				
<i>IEO92</i> . . . .		x	x		x				
<i>IEO93</i> . . . .		x	x		x				
<i>IEO94</i> . . . .			x	x	x				
<i>IEO95</i> . . . .			x	x	x				
<i>IEO96</i> . . . .		x	x	x	x	x			
<i>IEO97</i> . . . .			x	x	x	x			
<i>IEO98</i> . . . .			x	x	x	x	x	x	
<i>IEO99</i> . . . .			x	x	x	x	x	x	
<i>IEO2000</i> . .				x	x	x	x	x	
<i>IEO2001</i> . .				x	x	x	x	x	
<i>IEO2002</i> . .				x	x	x	x	x	
<i>IEO2003</i> . .				x	x	x	x	x	
<i>IEO2004</i> . .					x	x	x	x	
<i>IEO2005</i> . .					x	x	x	x	
<i>IEO2006</i> . .					x	x	x	x	x

Sources: Energy Information Administration, *International Energy Outlook*, DOE/EIA-0484 (Washington, DC, various years).

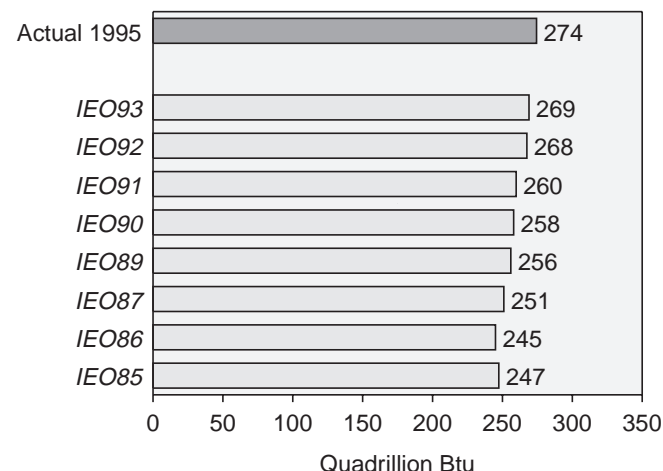
Similarly to the year 1995 projections, year 2000 projections were also consistently lower than actual 2000 data in each of the *IEOs* published between 1986 and 1993 (Figure H3). The consumption estimates for the market economies increased in each edition, from 265 quadrillion Btu in *IEO86* to 292 quadrillion Btu in *IEO93*. As late as 1993, the *IEO* forecasts were underestimating consumption of all energy sources in the market economies, by between 2 percent (oil) and 7 percent (natural gas and nuclear power).

**Figure H1. Comparison of *IEO* Forecasts with 1990 Energy Consumption in Market Economies**



Sources: Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site [www.eia.doe.gov/iea/](http://www.eia.doe.gov/iea/), and *International Energy Outlook*, DOE/EIA-0484 (Washington, DC, various years).

**Figure H2. Comparison of *IEO* Forecasts with 1995 Energy Consumption in Market Economies**



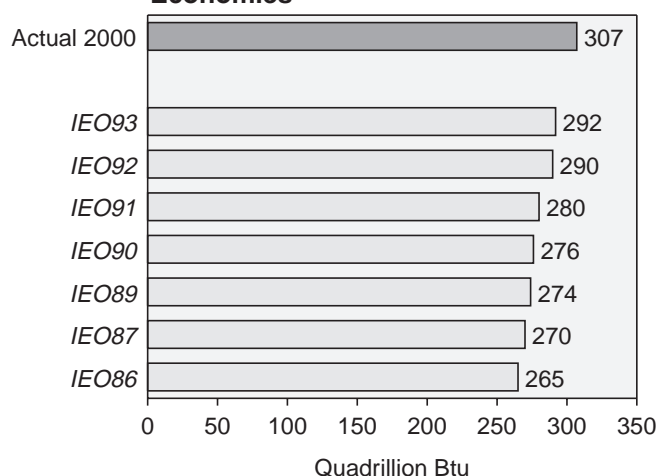
Sources: Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site [www.eia.doe.gov/iea/](http://www.eia.doe.gov/iea/), and *International Energy Outlook*, DOE/EIA-0484 (Washington, DC, various years).

As noted above, in the 1994 edition of the *IEO*, the regional aggregation “market economies” was dropped altogether and replaced with delineation of member countries of the OECD, Eurasia, and Rest of World (ROW). As a result of that reorganization, it is not possible to recreate a forecast for the CPE countries: except for China, the FSU, and Eastern Europe, the remaining CPE countries—listed above—were included in “other ROW.”

### Comparisons of Forecasts for Year 1995

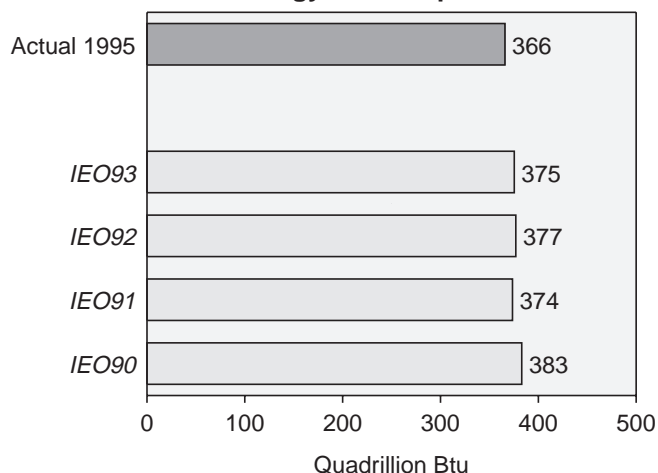
*IEO90* marked the first release of a worldwide energy consumption forecast. In *IEO90* through *IEO93*, the

**Figure H3. Comparison of *IEO* Forecasts with 2000 Energy Consumption in Market Economies**



Sources: Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site [www.eia.doe.gov/iea/](http://www.eia.doe.gov/iea/), and *International Energy Outlook*, DOE/EIA-0484 (Washington, DC, various years).

**Figure H4. Comparison of *IEO* Forecasts with 1995 World Energy Consumption**



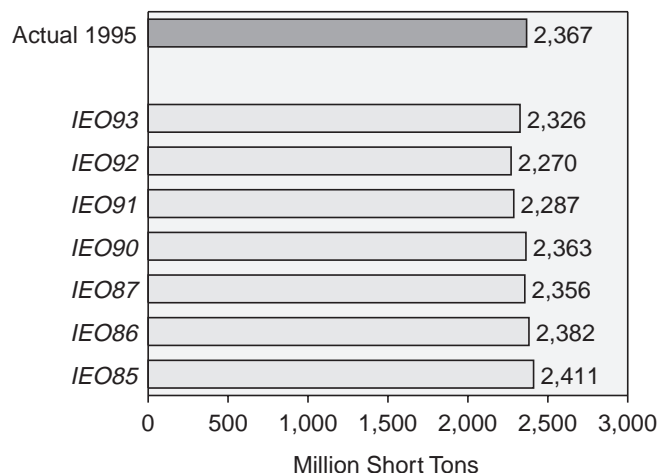
Sources: Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site [www.eia.doe.gov/iea/](http://www.eia.doe.gov/iea/), and *International Energy Outlook*, DOE/EIA-0484 (Washington, DC, various years).

forecasts for worldwide energy demand in 1995 were between 1 and 4 percent higher than the actual amounts consumed (Figure H4). Much of the difference can be explained by the unanticipated collapse of the Soviet Union economies in the early 1990s. The *IEO* forecasters could not foresee the extent to which energy consumption would fall in the FSU region. In *IEO90*, total energy consumption in the FSU was projected to reach 67 quadrillion Btu in 1995. The projection was reduced steadily in the next three *IEO* reports, but even in *IEO93* energy demand for 1995 in the FSU region was projected to be 53 quadrillion Btu, as compared with its actual 1995 energy consumption of 42 quadrillion Btu—a difference equivalent to about 5 million barrels of oil per day.

Forecasts for 1995 can also be compared in terms of their depiction of the fuel mix. Every *IEO* after 1990 projected the share of each energy source relative to total energy consumption within 2.6 percentage points of the actual 1995 distribution. The earliest *IEOs* tended to be too optimistic about the growth of coal use in the market economies (Figure H5) and too pessimistic about the recovery of oil consumption after the declines in the early 1980s that followed the price shocks caused by oil embargoes in 1973 and 1974 and the 1979-1980 revolution in Iran (Figure H6). The *IEO85* and *IEO86* reports projected that oil would account for only about 40 percent of total energy consumption for the market economies in 1995, whereas oil actually accounted for 45 percent of the total in 1995.

The 1995 forecasts for world coal consumption that appeared in the *IEOs* printed between 1990 and 1993 were consistently high, between 5 and 17 percent higher than actual coal use (Figure H7), largely because of

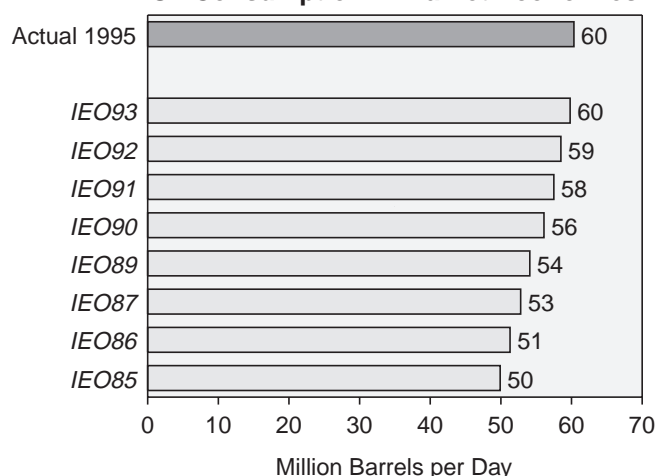
**Figure H5. Comparison of *IEO* Forecasts with 1995 Coal Consumption in Market Economies**



Sources: Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site [www.eia.doe.gov/iea/](http://www.eia.doe.gov/iea/), and *International Energy Outlook*, DOE/EIA-0484 (Washington, DC, various years).

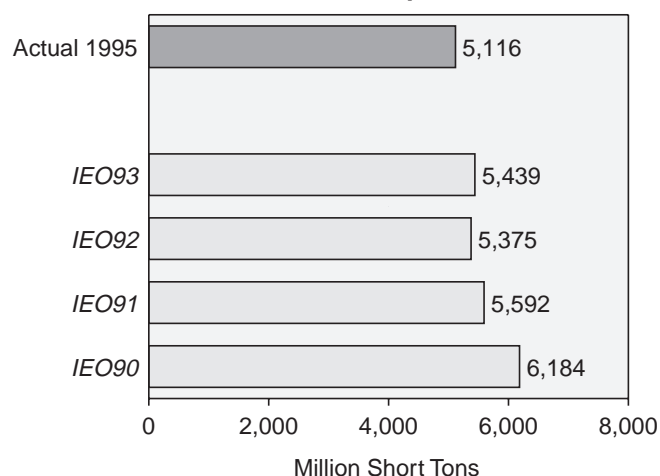
overestimates for the FSU and Eastern Europe—regions that experienced substantial declines in coal consumption during the years following the collapse of the Soviet Union. Most of the projections for the FSU by fuel were greater than the actual consumption numbers, with the exception of hydroelectricity and other renewable resources (Figure H8). Natural gas use in the FSU countries did not decline as much as oil and coal use, because natural gas is a plentiful resource in the region and was used extensively to fuel the domestic infrastructure; however, even the *IEO* estimates for 1995 natural gas use were 19 to 27 percent higher than the actual use.

**Figure H6. Comparison of *IEO* Forecasts with 1995 Oil Consumption in Market Economies**



Sources: Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site [www.eia.doe.gov/iea/](http://www.eia.doe.gov/iea/), and *International Energy Outlook*, DOE/EIA-0484 (Washington, DC, various years).

**Figure H7. Comparison of *IEO* Forecasts with 1995 World Coal Consumption**

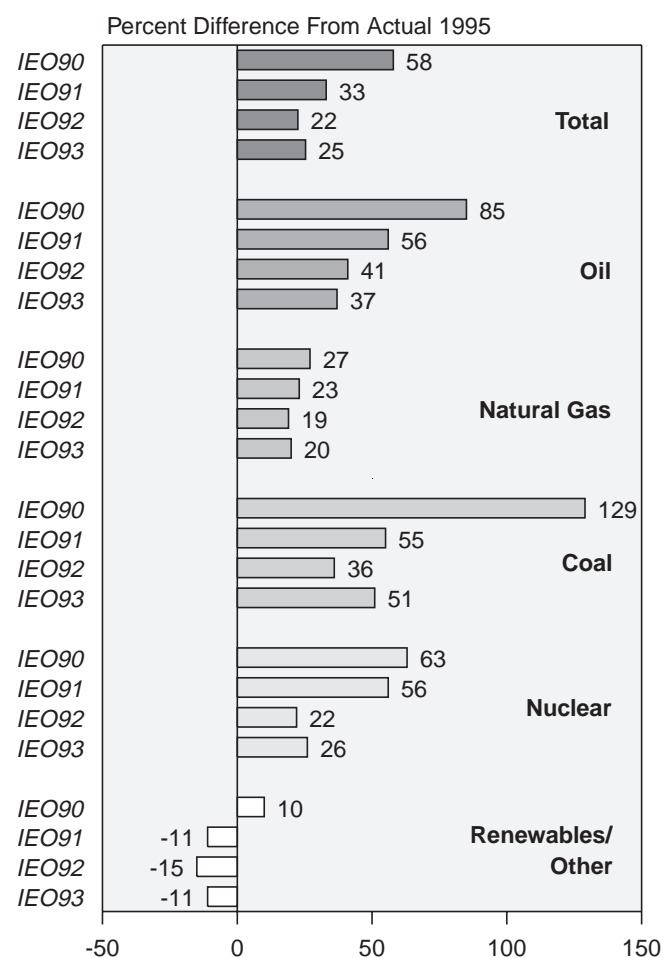


Sources: Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site [www.eia.doe.gov/iea/](http://www.eia.doe.gov/iea/), and *International Energy Outlook*, DOE/EIA-0484 (Washington, DC, various years).

The *IEO* projections for total energy consumption in China were below the actual 1995 consumption level in *IEO90* (by 12 percent) and *IEO91* (by 8 percent) but higher in *IEO92* (by 6 percent) and about the same in *IEO93*. The underestimates in the earlier *IEOs* balanced, in part, the overestimates for the EE/FSU countries; however, even the 4- to 14-percent underestimate of projected 1995 coal use in China could not make up for the 36- to 129-percent overestimate of FSU coal use.

For other fuels, the *IEO* forecasts consistently overestimated China's natural gas consumption and underestimated its oil consumption. Nuclear power forecasts were fairly close for China, within 5 percent of the actual consumption (Figure H9). It is noteworthy, however, that consumption of natural gas and nuclear power was quite small in 1995, so that any variation between actual historical consumption and the projections results in a

**Figure H8. Comparison of *IEO* Forecasts with 1995 Energy Consumption in the Former Soviet Union by Fuel Type**



Sources: Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site [www.eia.doe.gov/iea/](http://www.eia.doe.gov/iea/), and *International Energy Outlook*, DOE/EIA-0484 (Washington, DC, various years).

large percentage difference. EIA consistently underestimated economic growth in China. As late as 1993, EIA expected GDP in China to grow by about 7.3 percent per year during the decade of the 1990s, whereas it actually grew by 10.7 percent per year between 1990 and 1995.

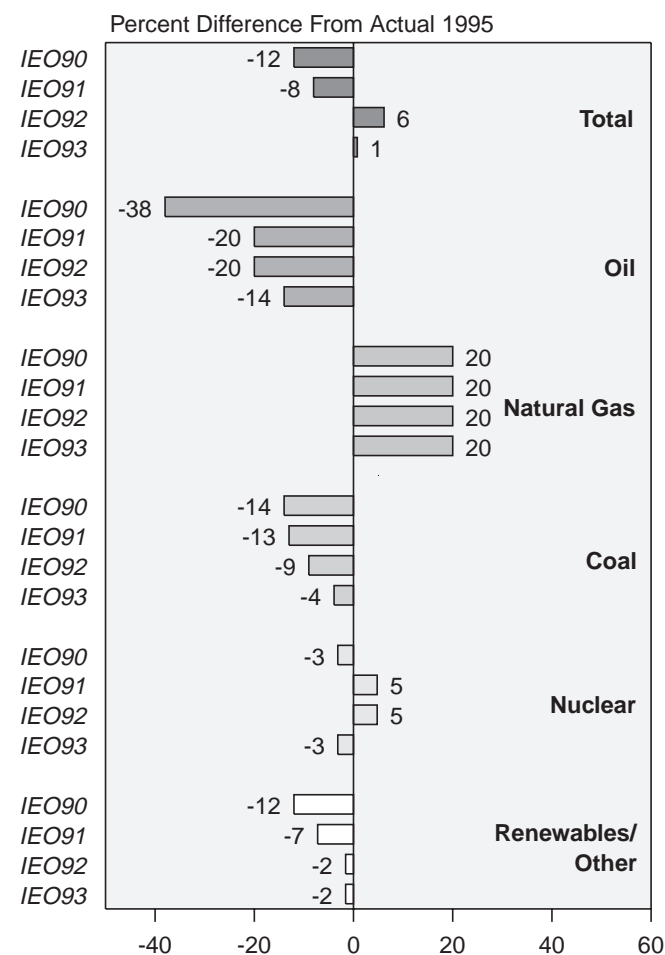
### Comparisons of Forecasts for Year 2000

Ten editions of the *IEO* report contained worldwide forecasts for the year 2000 (*IEO90* through *IEO99*). The forecasts of total world energy consumption for 2000 were all above, but within 5 percent of, the actual total (Figure H10). *IEO97* provided the highest estimate of world energy use in 2000. This may seem surprising at first glance, but it is also true that the economic recession that would take hold in 1998 among the emerging economies of southeast Asia had not occurred and was not foreseen in the *IEO97* forecast. In fact, *IEO97* overestimated year 2000 energy use in developing Asia by

9 quadrillion Btu, or about 12 percent (Figure H11) and in industrialized Asia (Japan, Australia, New Zealand, and the U.S. Territories) by 3 quadrillion Btu, or 9 percent.

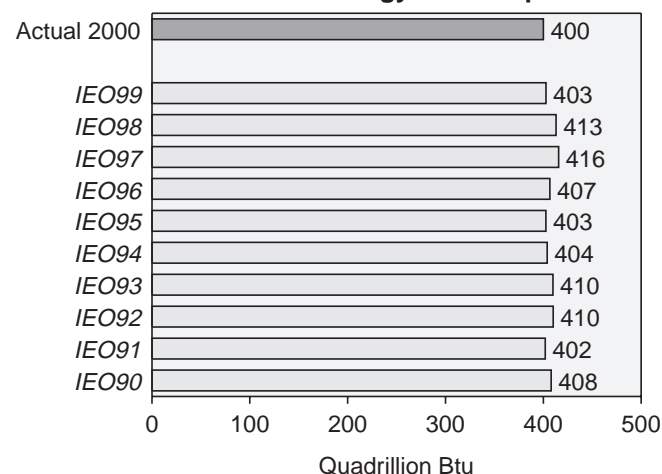
Projections for the EE/FSU in *IEO97* were also too optimistic, overestimating the rate of economic recovery in the region and as a result overestimating the growth in energy consumption by 12 quadrillion Btu (22 percent). *IEO97* did not anticipate the August 1998 devaluation of the Russian ruble and the economic recession that followed in the FSU region. By *IEO99*, total EE/FSU energy use had been adjusted downward to 52 quadrillion

**Figure H9. Comparison of *IEO* Forecasts with 1995 Energy Consumption in China by Fuel Type**



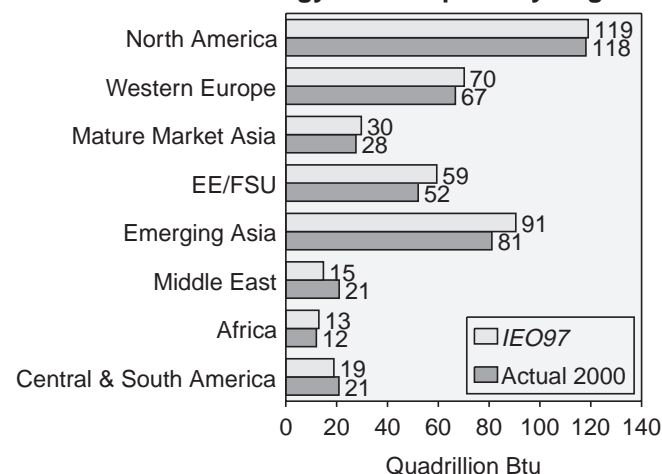
Sources: Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site [www.eia.doe.gov/iea/](http://www.eia.doe.gov/iea/), and *International Energy Outlook*, DOE/EIA-0484 (Washington, DC, various years).

**Figure H10. Comparison of *IEO* Forecasts with 2000 World Energy Consumption**



Sources: Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site [www.eia.doe.gov/iea/](http://www.eia.doe.gov/iea/), and *International Energy Outlook*, DOE/EIA-0484 (Washington, DC, various years).

**Figure H11. Comparison of *IEO97* Forecasts with 2000 Energy Consumption by Region**



Sources: Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site [www.eia.doe.gov/iea/](http://www.eia.doe.gov/iea/), and *International Energy Outlook 1997*, DOE/EIA-0484(97) (Washington, DC, April 1997).

Btu—just slightly lower than the region’s actual consumption in 2000.

The projections for year 2000 by fuel were mixed in terms of accuracy. For all energy sources except coal, total world consumption forecasts fell within 13 percent of the actual levels. As was the case with forecasts for the years 1990 and 1995, world coal consumption projections were consistently high relative to actual consumption in 2000. The world coal forecast presented in *IEO90* was 30 percent higher than actual 2000 values. The forecasts for the CPE countries were responsible for the large discrepancy between projected *IEO90* and actual coal consumption in 2000. In fact, *IEO90* projected that the market economies would consume 2,801 million short tons of coal in 2000, and the actual estimate for coal use among the market economies was 2,974. However, in the CPE countries—including the EE/FSU—*IEO90* projected that coal use would climb to 3,841 million short tons in 2000, whereas actual coal consumption was only 2,108 million short tons.

Much of the discrepancy between the *IEO90* projection and actual 2000 coal consumption can be attributed to the FSU. As noted above, *IEO90* did not foresee the collapse of the Soviet regime in 1990 when the report projections were prepared. Indeed, coal use in the FSU in *IEO90* was expected to expand to 1,132 million short tons in 2000, whereas in reality coal use in the FSU began to decline precipitously after 1990, hitting a low of 388 million short tons in 1998 before edging up to 400 million short tons in 2000. The story was similar for Eastern Europe and the other CPE countries (excluding China), where coal use in 2000 was overestimated by 202 percent in *IEO90*.

The year 2000 forecasts for oil, natural gas, and hydroelectricity and other renewable energy sources were, for the most part, higher than actual levels. In contrast, projections for nuclear power were consistently lower than the actual 2000 values. Interestingly, the forecasts for the United States were largely responsible for the underestimation. Even in *IEO99*—the latest *IEO* that included projections for 2000—analysts were expecting nuclear power to begin to decline. In *IEO90* there was widespread pessimism about the future of nuclear power in the mid-term, given the aftermath of the Chernobyl disaster and the problems associated with nuclear waste disposal. In the political climate of the early 1990s, *IEO90* could not anticipate the life extensions and consistently improving efficiencies that have allowed nuclear power plants to generate more electricity and operate with shorter downtimes for maintenance, even without expanding their installed capacities.

The comparison of *IEO* projections and historical data in the context of political and social events underscores the importance of those events in shaping the world’s energy markets. Such comparisons also point out how important a model’s assumptions are to the derivation of accurate forecasts. The political and social upheaval in the EE/FSU dramatically affected the accuracy of the projections for the region. On the other hand, if higher economic growth rates had been assumed for China, more accurate forecasts for that region might have been achieved. It is important for users of the *IEO* or any other projection series to realize the limitations of the forecasts. Failing an ability to predict future volatility in social, political, or economic events, the projections should be viewed as a plausible path or trend for the future and not as a precise prediction of future events.